

## Claims

1. An apparatus for determining the concentration of scale-forming ions; the apparatus comprising;  
5 a ligand which binds scaling ions in a sample of fluid, said ligand having an electronic configuration which is altered on binding of a scaling ion, said ligand being placed in the vicinity of a flow of said fluid;  
10 a detector for determining alterations in said electronic configuration, the amount of said alterations being indicative of the concentration of the scaling ion in the sample.
- 15 2. An apparatus according to claim 1 wherein the scaling ion is selected from the group consisting of  $\text{Ca}^{2+}$ ,  $\text{Ba}^{2+}$  and  $\text{Sr}^{2+}$  ions.
- 20 3. An apparatus according to claim 1 or claim 2 wherein the detector comprises one or more electrodes for determining changes in the electroactivity of said ligand.
- 25 4. An apparatus according to claim 3 wherein the ligand is immobilised on conducting particles attached to one or more of said electrodes.
- 30 5. An apparatus according to claim 4 such that wherein said conducting particles are carbon or metal particles.
6. An apparatus according to claim 5 wherein the metal particles are gold particles.

7. An apparatus according to any one of claims 4 to 6 wherein said particles with immobilised ligands thereon form a conducting porous electrode.

5 8. An apparatus according to claim 1 wherein a ligand comprises oxygen and/or nitrogen.

9. An apparatus according to any one of the preceding claims wherein the ligand is a BAPTA derivative.

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10. An apparatus according to any one of the preceding claims wherein the ligand is a cryptand derivative.

11. An apparatus according to any one of the preceding  
15 claims comprising a processor for calculating the concentration of the scaling ion in the sample water from alterations in the electronic configuration of the ligand.

20 12. An apparatus according to claim 11 comprising a ligand binding two or more different scaling ions and generating a different electronic configuration in response thereto.

25 13. An apparatus according to claim 11 comprising two or more different ligands, said detector being adapted to determine alterations in the electronic configuration of each ligand independently.

30 14. An apparatus according to claim 13 wherein each of the said two or more ligands binds to a different combination of scaling ions.

15. An apparatus according to any one of the preceding claims comprising a porous membrane which allows ions from fluid to contact the ligand.

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16. An apparatus according to claim 15 wherein the membrane is ceramic or zeolite.

17. An apparatus according to any one of the preceding claims comprising ligands embedded in a block of porous material, said block being exposed to a fluid flow.

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18. An apparatus according to any one of the preceding claims wherein the fluid is a wellbore effluent.

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19. An apparatus according to any one of the preceding claims wherein the fluid stems from a production flow from a wellbore.

20. An apparatus according to any one of the preceding claims being adapted to be placed in a subterranean location.

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21. A method of monitoring the concentrations of scaling ions comprising;

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contacting a fluid flow with a ligand which selectively binds scaling ions, wherein the binding of scaling ions in said sample to the ligand alters the electronic configuration of the ligand;

measuring changes in the electronic configuration of the ligand; and,

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determining the concentration of said scaling ion from said change in the electronic configuration.

22. A method according to claim 21 wherein the scaling ions are selected from the group consisting of  $\text{Ca}^{2+}$ ,  $\text{Ba}^{2+}$  and  $\text{Sr}^{2+}$  ions.

5 23. A method according to claim 21 or claim 22 wherein the change in electronic configuration is determined by measuring alterations in the electroactivity of the ligand.

10 24. A method according to any one of claims 21 to 23 wherein the ligand is a BAPTA derivative.

25. A method according to any one of claims 21 to 23 wherein the ligand is a cryptand derivative.

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25. A method according to any one of the preceding claims wherein the ligand binds two or more different scaling ions and generates a different electronic configuration in response thereto.

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26. A method according to any one of the preceding claims comprising contacting the sample with two or more different ligands and determining alterations in the electronic configuration of each ligand.

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27. A method according to claim 26 wherein each of the said two or more ligands binds to a different combination of scaling ions.

30 28. A method according to any one of the preceding claims including the step of monitoring the production of a wellbore.

29. A method according to any one of the preceding claims including the step of predicting the scaling of hydrocarbon production tubulars or equipment.

5. 30. A method according to any one of the preceding claims including the step of monitoring the scaling of hydrocarbon production tubulars or equipment in a downhole location.

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